

- workshop on raptor manage. and bio. in Alaska and western Canada. U.S. Fish and Wildl. Serv., Anchorage, AK.
- BORTOLOTTI, G. R. 1982. An easily assembled tree-top blind. *J. Field Ornith.* 53:179-181.
- BROLEY, C. L. 1947. Migration and nesting of Florida Bald Eagles. *Wilson Bull.* 59:3-20.
- CALL, M. 1979. Habitat management guides for birds of prey. U.S. Dept. Interior, Bureau Land Manage., Tech. Note T/N 338.
- GERRARD, J. M., P. N. GERRARD, G. R. BORTOLOTTI AND D. W. A. WHITFIELD. 1983. A 14-year study on Bald Eagle reproduction on Besnard Lake, Saskatchewan. Pages 47-57. *In* D. M. Bird, Ed. Bio. and manage. of Bald Eagles and Ospreys. Harpell Press, Ste. Anne de Bellevue, Quebec.
- GRUBB, T. G. 1980. An artificial Bald Eagle nest structure. U.S. Dept. Agric., For. Serv. Res. Note RM-383.
- HERRICK, F. H. 1932. Daily life of the American Eagle: early phase. *Auk* 49:307-323.
- MILLSAP, B. A., K. W. CLINE AND B. A. GIRON PENDLETON. 1987. Habitat management. Pages 215-237. *In* B. A. Giron Pendleton, B. A. Millsap, K. W. Cline and D. M. Bird, Eds. Raptor manage. tech. manual. National Wildlife Federation, Washington, D.C.
- OLENDORFF, R. R., R. S. MOTRONI AND M. W. CALL 1980. Raptor management—the state of the art in 1980. U.S. Dept. Interior, Bureau Land Manage., Tech Note 345.
- POSTUPALSKY, S. 1978. Artificial nest platforms for Ospreys and Bald Eagles. Pages 35-45. *In* S. A. Temple, Ed. Endangered birds: management techniques for preserving threatened species. Univ. Wisconsin Press, Madison.
- SCHMUTZ, J. K., R. W. FYFE, D. A. MOORE AND A. R. SMITH. 1984. Artificial nests for Ferruginous and Swainson's hawks. *J. Wildl. Manage.* 48:1009-1013.

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## FEEDING RESPONSES BY GYRFALCONS TO BROOD SIZE MANIPULATION

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Studies of food consumption by raptors with natural broods of varying sizes have produced equivocal results. Some workers reported little or no difference in total food consumption/nest among broods of varying sizes (Snyder and Wiley 1976; Newton 1978; Simmons 1986), whereas others found total biomass consumed/brood was greater in larger broods, although not proportional to the number of young (Anderson et al. 1972; Snyder and Snyder 1973; Green 1976; Drent and Daan 1980; Nielsen 1986). From 1984-1986, I examined food habits and feeding behavior of Gyrfalcons (*Falco rusticolus*) in the central Canadian Arctic (Poole 1987; Poole and Boag 1988). In natural broods I found that prey biomass delivered/nest varied directly with the number of chicks. In addition time spent feeding by the brood each day was slightly longer for larger

broods, but the number of feeding events (direct feeding or food delivery [Jenkins 1978]) per day (feeding rate) did not vary with brood size. In an attempt to clarify the reasons for these results I manipulated brood size in two Gyrfalcon nests in 1986 and recorded feeding response of the adults.

Two nests were located on the Kilgavik study area in the central Arctic of the Northwest Territories (68°10'N, 106°15'W). The region is composed of rugged mainland tundra and contains low-arctic flora. A general description of the vegetation, climate and geology of the area is reported elsewhere (Poole and Bromley 1988).

Nests were selected in which the oldest nestlings were the same age, and both nests were considered large enough (4 × 1.5 m ledges) to accommodate additional young. At

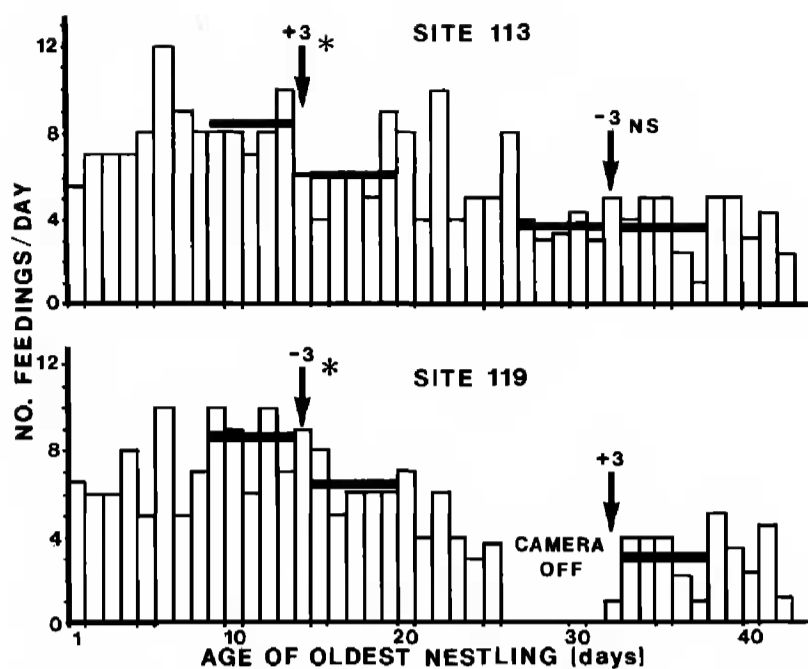


Figure 1. Feeding rate at Sites 113 and 119 during brood size manipulation, Kilgavik, N.W.T., 1986. Arrows denote addition (+3) or removal (-3) of three chicks. Horizontal bars indicate 5-day means before and after manipulation; *t*-test between means, \* =  $P \leq 0.05$ , NS =  $P > 0.05$ .

Site 113 two female nestlings hatched 1 d apart; at Site 119, 30 km to the east, three females and one male hatched within 3 d.

When the oldest nestlings were 14 d old, one male and two females from Site 119 were moved to Site 113, changing original brood sizes from four to one and two to five, respectively. During the experiment the nests were visited 3 times: at the time broods were initially changed, again when young were 25 d old, and again when young removed from Site 119 were returned to their natal site at 32 d of age.

Time-lapse 8 mm movie cameras (Temple 1972) provided a sampled documentation (three to six min intervals) of activities at the nest, including attendance by adults and frequency and durations of feeding bouts. A period of 5 d before and after both changes in brood size was used for examination of response in feeding rates and total time feeding each day. A 10-d period was chosen for data collection as the best compromise between a period too short to encompass a possible delay in foraging response after manipulation (Snyder and Snyder 1973), yet short enough to fall within similar periods of nestling growth (linear growth occurs between 6–27 d of age [Poole 1987]).

Each site was visited 10 times during the entire nestling period. On each visit prey remains and pellets were collected from the nest, at the base of the nest cliff, and at accessible perches and plucking sites to determine the species and biomass of prey eaten since the previous visit. The minimum number of individuals in each collection was

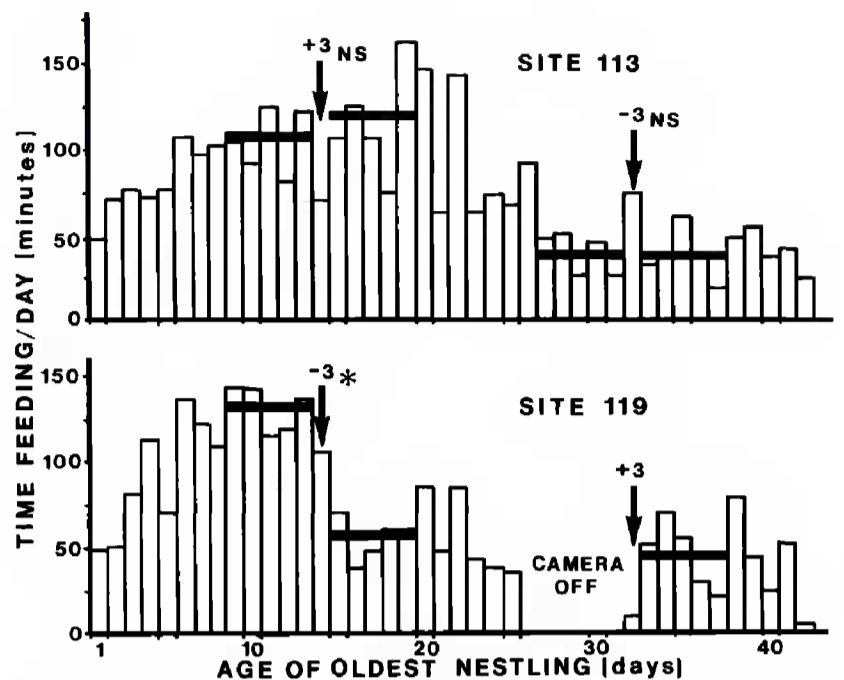


Figure 2. Time feeding/d at Sites 113 and 119 (see Fig. 1 for explanation).

determined by counting the most frequently occurring bone or body part that represented one individual. Mean prey biomass used/d during each period covered by a collection was examined for approximately 1 wk before, during, and one wk after the manipulation experiment, corresponding to timing of prey collections. Weights of chicks were obtained on most (seven to nine) visits.

Following addition of three nestlings to Site 113, feeding rate declined (Fig. 1). The post-manipulative feeding rate was significantly lower (*t*-test,  $P = 0.02$ ) when 5-d pre- and post-manipulation periods were compared. Total post-manipulation time feeding increased slightly, but not significantly ( $P > 0.5$ ; Fig. 2). A similar post-manipulation comparison was not possible at Site 119 because of camera malfunction. Reduction in brood size at Site 119 was followed by a significant decline in both feeding rate ( $P = 0.05$ ; Fig. 1) and total time feeding/d ( $P < 0.01$ ; Fig. 2). No change occurred when nestlings were removed at Site 113 in either feeding rate ( $P > 0.5$ ) or total time feeding ( $P > 0.5$ ).

Mean biomass of prey used/d at each site increased with larger brood size (Table 1; comparing mean biomass (BM) used/d in each period with brood size (BS), combining sites:  $BM = 153BS + 525$ ,  $r = 0.98$ ,  $P = 0.001$ ,  $N = 6$ ). Adult female Gyrfalcons were observed to eat occasionally at nests and perches where prey remains were collected and were counted as one "chick" for calculations. When mean biomass of prey/"chick"/d was calculated, chicks in the larger broods received less on a per capita basis (Table 1; combining sites:  $BM = -29BS + 347$ ,  $r = -0.93$ ,  $P < 0.01$ ,  $N = 6$ ). Mean prey weight increased throughout the nestling period at both sites (Table 1).

No weights of chicks were obtained at Site 113 after original brood size was restored, precluding comparison

Table 1. Mean biomass of prey/d and prey/chick/d, and mean prey weight at Sites 113 and 119, at which brood sizes were experimentally manipulated, Kilgavik, NWT, 1986.

	Site 113		Site 119			
	2	5	2	4	1	4
No. chicks	2	5	2	4	1	4
Age of oldest chick (d)	8-14	14-32	32-40	7-14	14-32	32-38
Mean prey biomass/d (g)	803	1269	841	1221	684	1092
Mean prey biomass/"chick"/d (g) <sup>a</sup>	268	212	280	244	342	218
Mean prey weight (g)	438	544	560	389	456	546

<sup>a</sup> "Chick" includes nestlings and adult female; see text.

of growth rates with different brood sizes. The most reliable indication of effect of brood size on chick weight is given by comparing weight of the female nestling that stayed alone at Site 119 (Chick A) with the same-age female sibling transferred to Site 113 (Chick B). Chick A was 40-65 g (12-26%) lighter than its sibling during the seven d prior to the initial manipulation. Midway through the manipulations weights of both chicks were virtually identical (5 g difference), and when the original brood sizes were restored Chick A was 185 g (15%) heavier than its sibling, indicating that once alone Chick A grew faster. Chick B's weight increased to within 45 g (3%) of Chick A's weight when final measurements were made 6 d after the last manipulation.

Adult Gyrfalcons at each nest appeared to respond to alterations in brood size by compensatory changes in total prey biomass fed to nestlings and, to a lesser degree, in total time spent feeding nestlings each day. However, feeding rates did not show a similar pattern of response, probably because of inherent biases involved in calculation of feeding rate. For example, five passerines eaten in 1 d would have the same rate as five Rock Ptarmigan (*Lagopus mutus*), but vastly different total time spent feeding and total biomass consumption. Secondly, caching, observed regularly into the fourth week post-hatch (Poole and Boag 1988), would also confound analysis based on rate alone. The same rate could result from one ptarmigan fed to one nestling three times, or a whole ptarmigan fed to a larger brood on each of three occasions. Thus, feeding rate must be used cautiously when prey of greatly differing sizes are taken or are too large to be consumed completely in one feeding. In such cases examination of prey biomass consumed may be more appropriate. The general trend at both nests was an increase then gradual decrease in feeding rate with increasing age of young, a pattern also found at unmanipulated sites (Poole and Boag 1988).

Despite evidence that adults were able to adjust biomass of prey killed, the changes were not in the two to five or four to one ratio expected if adults were responding linearly to the number of young in the nest. According to von Haartman (1954 cited in Drent and Daan 1980), food consumption by each brood is a compromise between nestling demand and the effort required by parents to supply

food. Nestlings in smaller broods in my study received more biomass/d than their counterparts in larger broods, such that in smaller broods nestlings may have been "over-fed" to some degree (Newton 1979). Development of all chicks appeared normal.

Although based on a limited sample, these results suggest that Gyrfalcon pairs were able to adjust prey biomass supplied during the nestling period in response to the number of young.

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#### LITERATURE CITED

- DRENT, R. H. AND S. DAAN. 1980. The prudent parent: energetic adjustments in avian breeding. *Ardea* 68:225-252.
- ENDERSON, J. H., S. A. TEMPLE AND L. G. SWARTZ. 1972. Time-lapse photographic records of nesting Peregrine Falcons. *Living Bird* 11:113-128.
- GREEN, R. 1976. Breeding behaviour of Ospreys *Pandion haliaetus* in Scotland. *Ibis* 118:475-490.
- VON HAARTMAN, L. 1954. Der Trauerfliegenschnapper. III. Die Nahrungsbiologie. *Acta Zool. Fenn.* 83:1-96.
- JENKINS, M. A. 1978. Gyrfalcon nesting behavior from hatching to fledging. *Auk* 95:122-127.
- NEWTON, I. 1978. Feeding and development of Sparrowhawk *Accipiter nisus* nestlings. *J. Zool., Lond.* 184: 465-487.
- . 1979. Population ecology of raptors. Buteo Books, Vermillion, SD.
- NIELSEN, Ó. K. 1986. Population ecology of the gyrfal-

- con in Iceland, with comparative notes on the merlin and the raven. Unpubl. Ph.D. thesis, Cornell Univ., Ithaca, New York.
- POOLE, K. G. 1987. Aspects of the ecology, food habits and foraging characteristics of Gyrfalcons in the central Canadian Arctic. Unpubl. M.Sc. thesis, Univ. of Alberta, Edmonton.
- POOLE, K. G. AND R. G. BROMLEY. 1988. Natural history of the gyrfalcon in the central Canadian Arctic. *Arctic* 41:31-38.
- POOLE, K. G. AND D. A. BOAG. 1988. Ecology of gyrfalcons, *Falco rusticolus*, in the central Canadian Arctic: diet and feeding behaviour. *Can. J. Zool.* 66:334-344.
- SIMMONS, R. 1986. Food provisioning, nestling growth and experimental manipulation of brood size in the African Redbreasted Sparrowhawk *Accipiter rufiventris*. *Ornis Scand.* 17:31-40.
- SNYDER, N. F. R. AND H. A. SNYDER. 1973. Experimental study of feeding rates of nesting Cooper's Hawks *Condor* 75:461-463.
- SNYDER, N. F. R. AND J. W. WILEY. 1976. Sexual size dimorphism in hawks and owls of North America. *Ornith. Monogr.* No. 20.
- TEMPLE, S. A. 1972. A portable time-lapse camera for recording wildlife activity. *J. Wildl. Manage.* 36:944-947.

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## USE OF AN ORAL IMMOBILIZING AGENT TO CAPTURE A HARRIS' HAWK (*Parabuteo unicinctus*)

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A 5 yr old, captive bred Harris' Hawk (*Parabuteo unicinctus*) routinely used for falconry purposes was lost while being flown during a severe thunderstorm in the spring of 1987. The hawk was wearing a single 216 MHz transmitter (Beacon Products, Salt Lake City, Utah) attached to a tail mount. Using a radio receiver (Rb-4 Falconer, Custom Electronics, Urbana, Illinois), the hawk was relocated the following day.

For 6 d the hawk was observed catching and feeding on numerous small rodents. The hawk was also observed robbing several Black-billed Magpie (*Pica pica*) nests of newly hatching nestlings. Due to the abundant availability of prey the hawk refused to return to the falconer when offered food. Several attempts were made to trap the hawk using pigeons (*Columba* sp.) and quail (*Coturnis* sp.) and various Bal-Chartri traps (Berger, D. and Mueller, H., The Bal-Chartri: a trap for the birds of prey. *Bird-Banding* vol. XXX, January 1959). The hawk cautiously avoided all trapping attempts and would only accept food items from the falconer if left near the perching hawk, or if food was thrown in the hawk's direction.

Previous capture methods being unsuccessful, chemical immobilization was considered as a means of retrieving the hawk. Because of possible impact damage caused by an anesthetic dart, traditional methods of administering an immobilizer were unacceptable. Since the hawk was

indirectly accepting food from the falconer, an alternative was to use an immobilizing agent injected into food that, following ingestion, would act to slow the hawk enough for capture.

Oral immobilizing agents have been used to capture wild birds (Martin, L. L., Comparison of methozymol, Alpha-chloralose and two barbiturates for capturing doves. Proceedings of the 21st. Annual Conference of the Southeastern Association of Game and Fish Commissioners, 1967; William, L. and Philips, R., Capturing Sandhill Cranes with alpha-chloralose. *J. Wildl. Mgmt.* 37(1): 94-97, 1973). Ketamine HCl, however, has apparently not been used as an oral immobilizing agent for capturing birds. Effective oral doses of ketamine HCl are usually 2-3 times higher than Parenteral doses (Fowler, M., Zoo and wild animal medicine, 2nd. ed. W.B. Saunders Company, Philadelphia, PA, 1986), and oral immobilizing agents have previously been rejected as a poor means of restraining wild animals (Fowler 1986).

Ketamine HCl (Ketaset®-Bristol Veterinary Products) at a dosage of 100 mg/kg<sup>a</sup> was injected into a 30 gm piece

<sup>a</sup> Routine intramuscular dosage for large raptors is 20-30 mg/kg, when not given simultaneously with Xylozine or Diazepam (P. Redig, pers. comm.).